



INTELLECTUAL PROPERTY
DEPARTMENT
RECEIVED

Invention Disclosure

AUG 01 2000

Name: Chok Ho

Date: 07/31/00

Tel No: (510) 572-4106

Fax No: (510) 572-8129

Internal e-mail (MSMail or TeamLinks): Chok.Ho@lamrc.com
Artin.Tang@lamrc.com
Charlie.Lee@lamrc.com

1a. Project Name: Use of Ammonia (NH3) for Etching SiLK, an organic Low-k Dielectric.

1b. Technology: Dielectric Etch

1c. Business: (Circle One) •Conductor Etch •Dielectric Etch •CMP •Clean
•New Product Development •Platform Engineering •Software
Other _____

1d. Lam Product(s): Exelan-HP

2. Title or subject matter of your invention:

Use of Ammonia (NH3) for Etching SiLK, an organic Low-k Dielectric.

Lam Legal Confidential

CH_072000B_Invention_Disclosure

BEST AVAILABLE COPY

3. Please attach a brief, yet thorough, description of what your invention is and how your invention operates or performs. Describe the preferred and alternative ways in which your invention would be implemented. Attach and identify copies of all known drawings, sketches, (flow-charts for software), formulae, descriptions, data, articles, etc., of your invention, including copies of your lab notebook entries (dated and witnessed).

NH₃ is used to etch SiLK, an organic low-k dielectric. NH₃ is used because it has a much lower ionization potential than traditional etchants of SiLK, such as N₂/H₂. Because of the lower ionization potential, higher plasma density and higher SiLK etch rate can be achieved using NH₃ rather than N₂/H₂ for the same process conditions. In addition, the NH₃ plasma is much more stable than a N₂/H₂ plasma, given the same processing condition. We believe that where there is insufficient ion bombardment, such as on the sidewalls of the Vias/Trenches, NH₃ reacts with the SiLK and forms a polymer consisting of (=CH-N=)_n groups arranged in a 3-dimensional matrix. The HCN polymer passivates the sidewall and prevents profile bowing.

- 4a. Describe any prior art (e.g., known existing products, methods, publications or patents) of which you are aware and which relate to your invention:
- 4b. State in detail the advantages that your invention has over this prior art and how your invention distinguishes over this prior art:

The use of NH₃ has many advantages over prior chemistries for etching SiLK. NH₃ has a much lower ionization potential than N₂, a component of prior chemistries used for etching SiLK; this leads to the following advantages over other traditional methods for etching SiLK:

- Higher SiLK etch rates, about 2.5 times higher etch rate than using N₂/H₂ chemistry.
- Profile angle is independent of feature size. All feature sizes show very similar profile angles.
- Forms an HCN-type polymer on the sidewall of the SiLK Via/Trench structures which passivates the sidewalls to prevent profile bowing due to lateral etching/ion bombardment and also prevents poisoning of the structures due to outgassing of solvent from the SiLK during subsequent barrier metal deposition.
- Higher selectivity of SiLK to Oxide or Nitride hardmask materials.
- Allows for a more stable plasma over a wider pressure and power operations regime than N₂ containing chemistries.

Lam Legal Confidential

CH_072000B_Invention_Disclosure

5. Conception/Reduction/Commercial Use:

Date of first conception: [REDACTED]

Date of first notebook entry: [REDACTED]

Where conceived?: Fremont, CAWas invention reduced to practice (made/used)? (yes/no): Yes

If yes, date first reduced: [REDACTED]

Is commercial or public use planned (yes/no): [REDACTED]

If yes, date of expected or actual public disclosure or offer for sale: [REDACTED]

Was invention result of co-development project with others? (yes/no): No

If yes, explain (include whether NDA in place):

6. Did invention occur during performance of a government contract? (yes/no): No
If yes, explain:**7. Give names of other persons familiar with or who have worked on the project, but who do not claim an inventorship interest in the invention (please identify the project or intended product):****Reza Sadjadi, Jim Tietz, John Lang, Rao Annapragada****Lam Legal Confidential****CH_072000B_Invention_Disclosure**

8. For each inventor, please provide the following information (copy & paste as necessary):

8a. Legal Name (as you intend to sign application): Chok W. Ho

Employee #: 4935

Dept #: 20011

M/S: CA3

Extension: 4106

e-mail: Calmouse@Yahoo.com

Residential Address (City, County, State & Zip): 372 Meadowhaven Way,
Milpitas, CA 95035

Mailing Address (if different from Residential): _____

Citizenship: U.S.

Names of Supervisor, Director, and Vice President: Reza Sadfadi, Jim Tietz,
Nick Bright

8b. Legal Name (as you intend to sign application): Artin Tang

Employee #: 20055

Dept #: 20071

M/S: TWN1

Extension: 011-886-35798666

e-mail: Artin.Tang@lamrc.com

Mailing Address (if different from Residential): 1st Floor, No. 22 R&D Road II,
Science-based Industrial Park, Hsin-chu, Taiwan, R. O. C.

Citizenship: Taiwan

Lam Legal Confidential

CH_072000B_Invention_Disclosure

8c. Legal Name (as you intend to sign application): Charlie Lee

Employee #: 21319

Dept #: 20071

M/S: TWN1

Extension: 011-886-35798666

e-mail: Charlie.Lee@lamrc.com

Mailing Address (if different from Residential): 1st Floor, No. 22 R&D Road II,
Science-based Industrial Park, Hsin-chu, Taiwan, R. O. C.

Citizenship: Taiwan

Names of Supervisor, Director, and Vice President: Alfred Tsai, Young-Tong Tsai,
Daniel Liao

9. Inventor's Signature(s) and date signed:

Chieh W. Ho 8/1/2000

10. Witnessed & Understood By (Include date):

Rao Annapragada 8/1/2000.

THIS FORM IS Lam RESEARCH NEED-TO-KNOW CONFIDENTIAL DATA WHEN FILLED IN. Please send the completed form to Intellectual Property Law Group, Lam Research Corp., Law Department, M/S CA1, 4650 Cushing Pkwy, Fremont CA 94538.

Lam Legal Confidential

CH_072000B_Invention_Disclosure

LAM FLARE TEST WATER

201/8407

2022/1/8

MAY. 6. 2005 3:09PM

16509618301

EGL

BPP

NO. 5227

P. 1878

PROJECT:

NH3 (SILK STD.)

Module ID: 8302

System: Eulen-HP
 Eng: CHOKW HO
 Date: 05/18/00

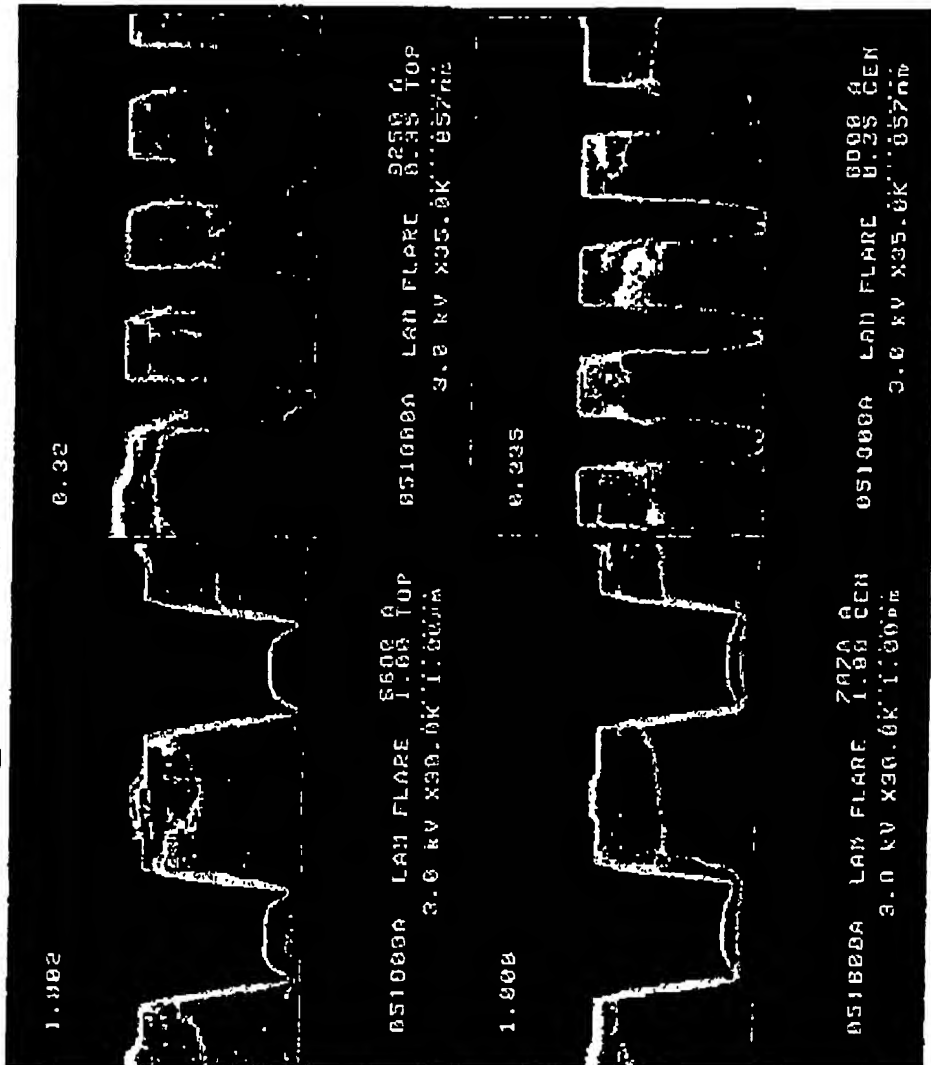
| Section | Vial ID | MT | CHEMISTRY | | | | | | | | | | (mL) | PK | TIME | RWD | .V6 | COMMENTS |
|---------|---------|-----|-----------|--------|-------|----|----|----|----|------|------|-------|------|------|------|------|-----|-----------------|
| | | | PRESS | 27 MHz | 1 MHz | Ar | N2 | O2 | CO | C6H6 | C7H8 | CH2F2 | CH3F | NH3 | | | | |
| 25 | 051800A | 70 | 500 | 1K | 160 | | | 15 | | 5 | 40 | | | | 30 | 45 | 480 | ESCO -10°C |
| | | 55 | 1400 | 1K | 140 | | | 9 | | 15 | | | | | 10 | 357 | 590 | |
| | | 160 | 700 | - | | | | | | | | | | 1000 | 90 | 39.4 | 380 | |
| 24 | 051800B | 70 | 500 | 1K | 160 | | | 15 | | 5 | 40 | | | | 30 | 44 | 450 | ESCO -10°C |
| | | 55 | 1400 | 1K | 140 | | | 9 | | 15 | | | | | 10 | 34.8 | 542 | May 18 - 01.04X |
| | | 100 | 500 | - | | | | | | | | | | 600 | 130 | 36.5 | 328 | |
| 23 | 051800C | 70 | 500 | 1K | 160 | | | 15 | | 5 | 40 | | | | 30 | | | ESCO -10°C |
| | | 55 | 1400 | 1K | 140 | | | 9 | | 15 | | | | | 10 | | | May 18 - 01.05X |
| | | 160 | 700 | - | | | | | | | | | | 600 | 90 | 90 | 353 | |

06/11/2000

CA 8/1/2000

Wafer # 051800A (ESC @ -10°C)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 30"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 160 mT/ 700/ 0/ 1000 NH3/ 90"

ER = 5269 A/min; ER Uniformity \leq 3.4%; RIE Lag = -40.1%



Confidential

07/31/00 Chok Ho (Silk Etch Development)

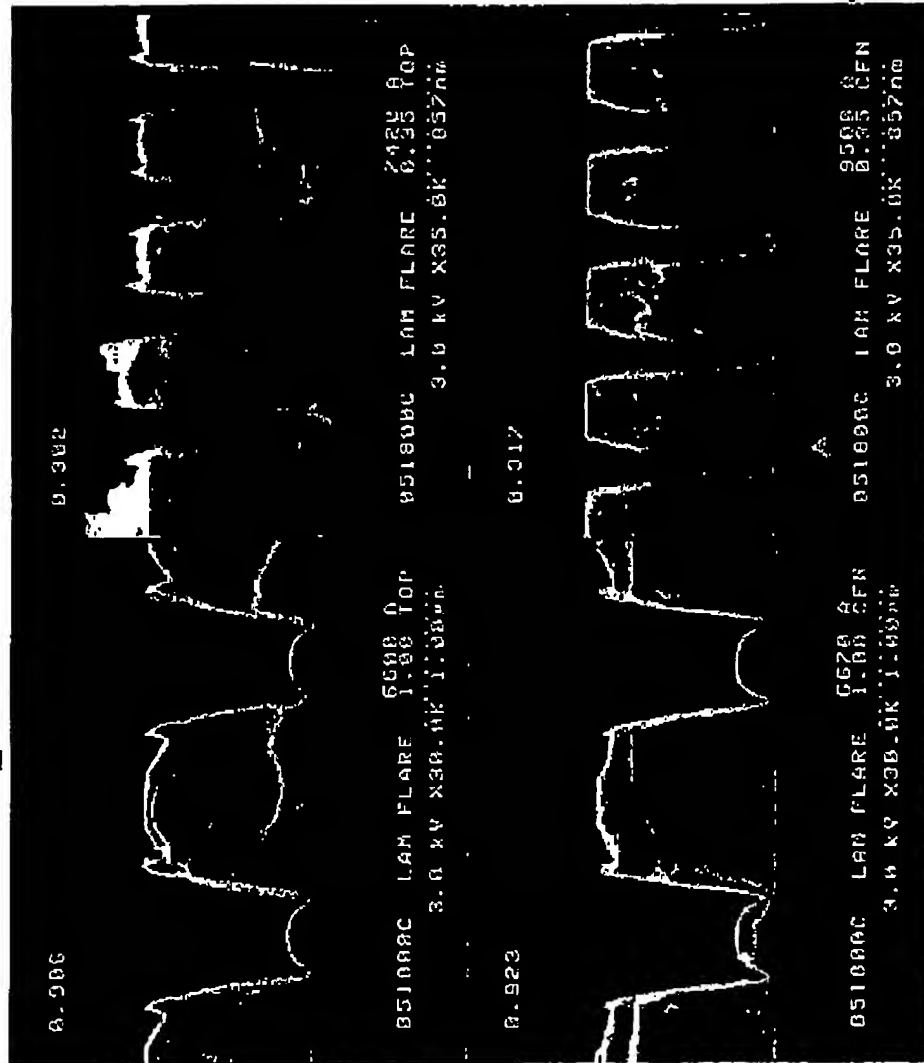
Wafer # 051800C (ESC @ -10°C)

70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 30"

55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"

160 mT/ 700/ 0/ 600 NH3/ 90"

ER = 5032 A/min; ER Uniformity \leq 12.3%; RIE Lag = -42.4%



Confidential

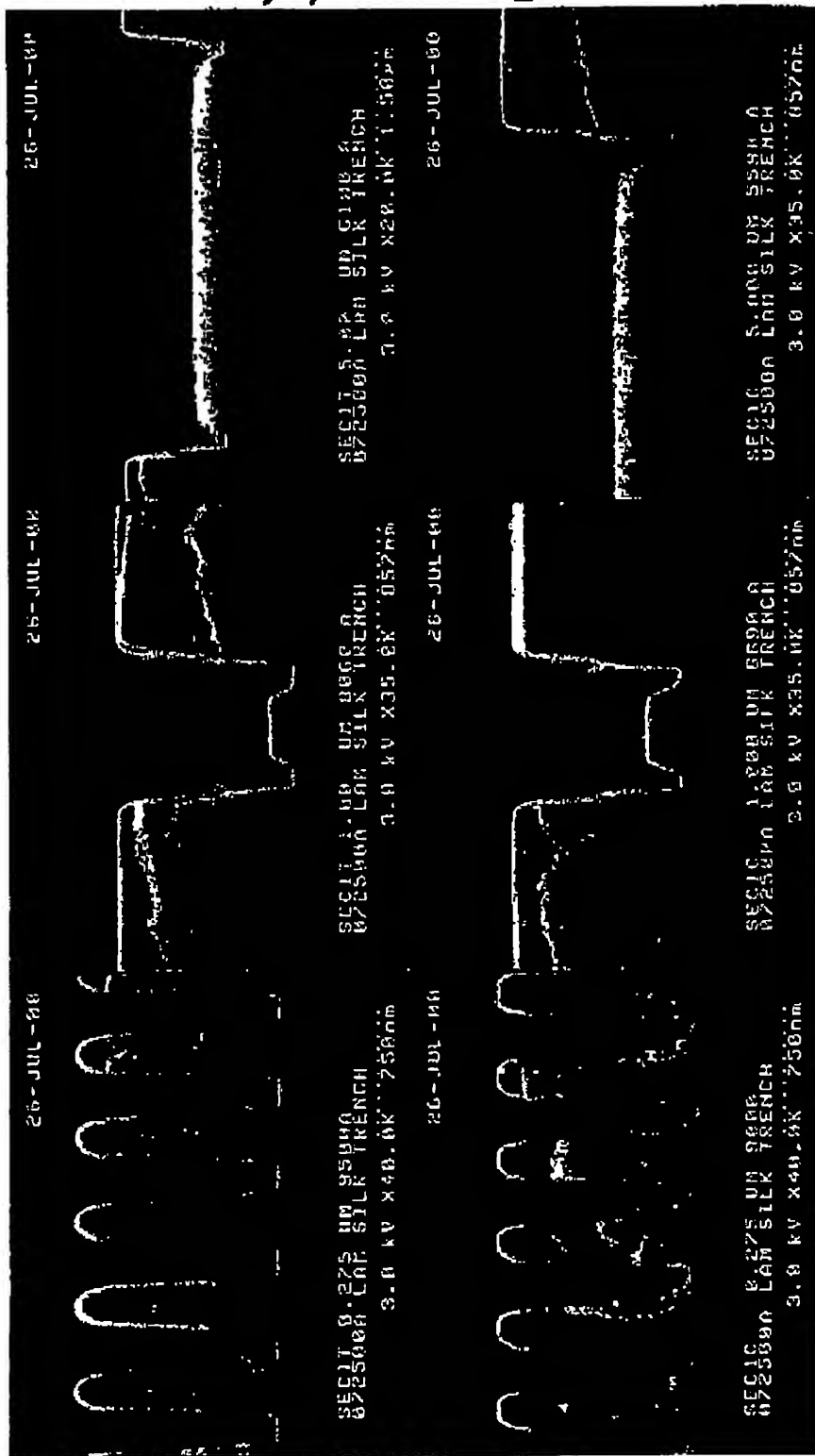
07/31/00 Chok Ho (SILK Etch Development)

02/1/02

02/1/02

Wafer # 072500A (ESC @ 0°C) (Partial Etch)
 70 MT/ 500/ 1K/ 160 A/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 A/ 9 O2/ 15 C4F8/ 10"
 60 mT/ 500/ 0/ 300 NH3/ 150"

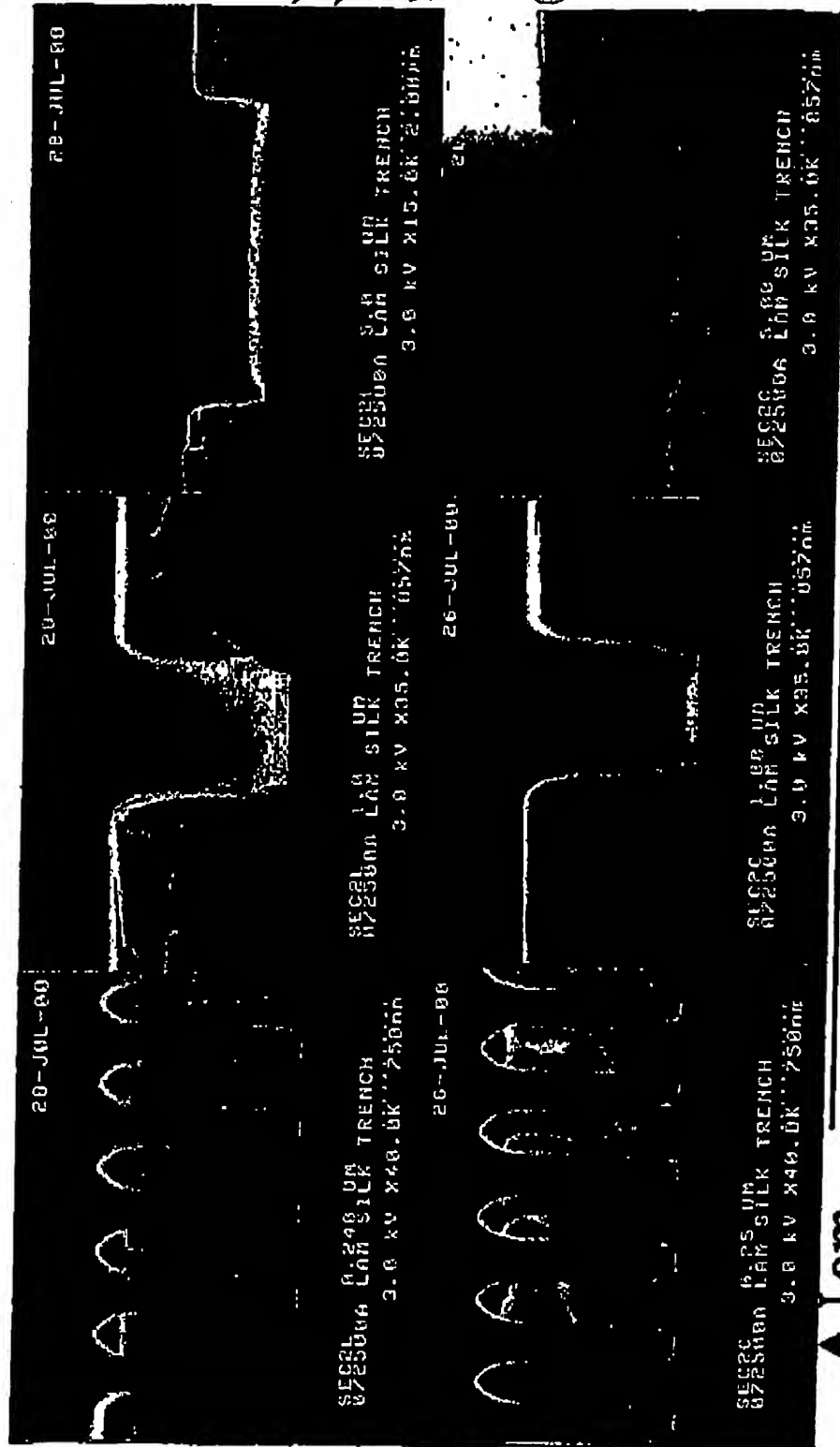
ER = 3325 A/min; ER Uniformity \leq 9.3%; RIE Lag = - 34.5%



Confidential

07/31/00 Chok Ho (Silk Etch Development)

Wafer # 072500A (ESC @ 0°C) (57.5% Overetch)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 60 mT/ 500/ O/ 300 NH3/ 270"

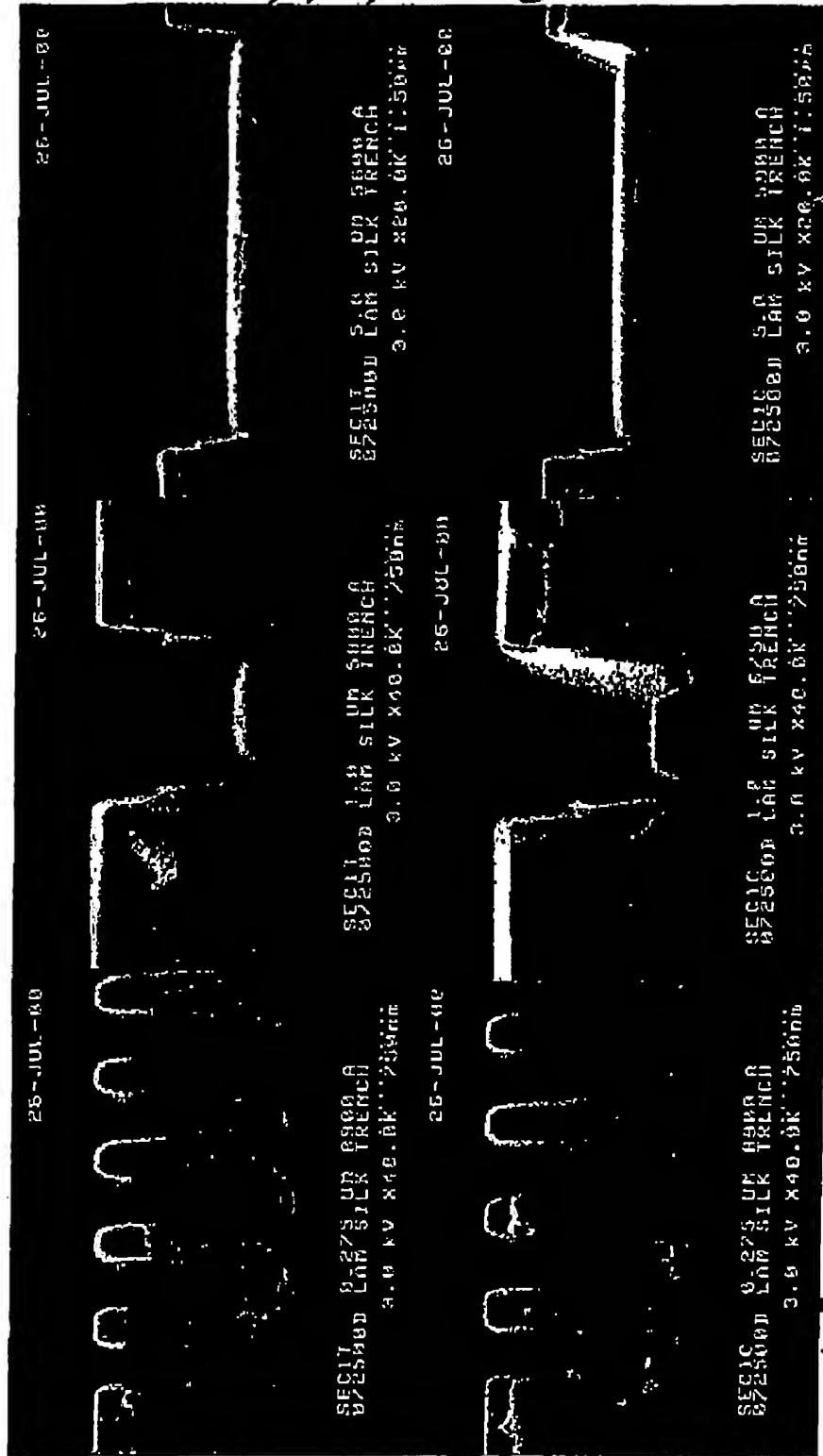


Confidential

07/31/00 Chok Ho (SILK Etch Development)

Wafer # 072500B (ESC @ 0°C) (Partial Etch)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 160 mT/ 500/ 0/ 600 NH3/ 115"

ER = 3959 A/min; ER Uniformity \leq 7.6%; RIE Lag = -53.4%

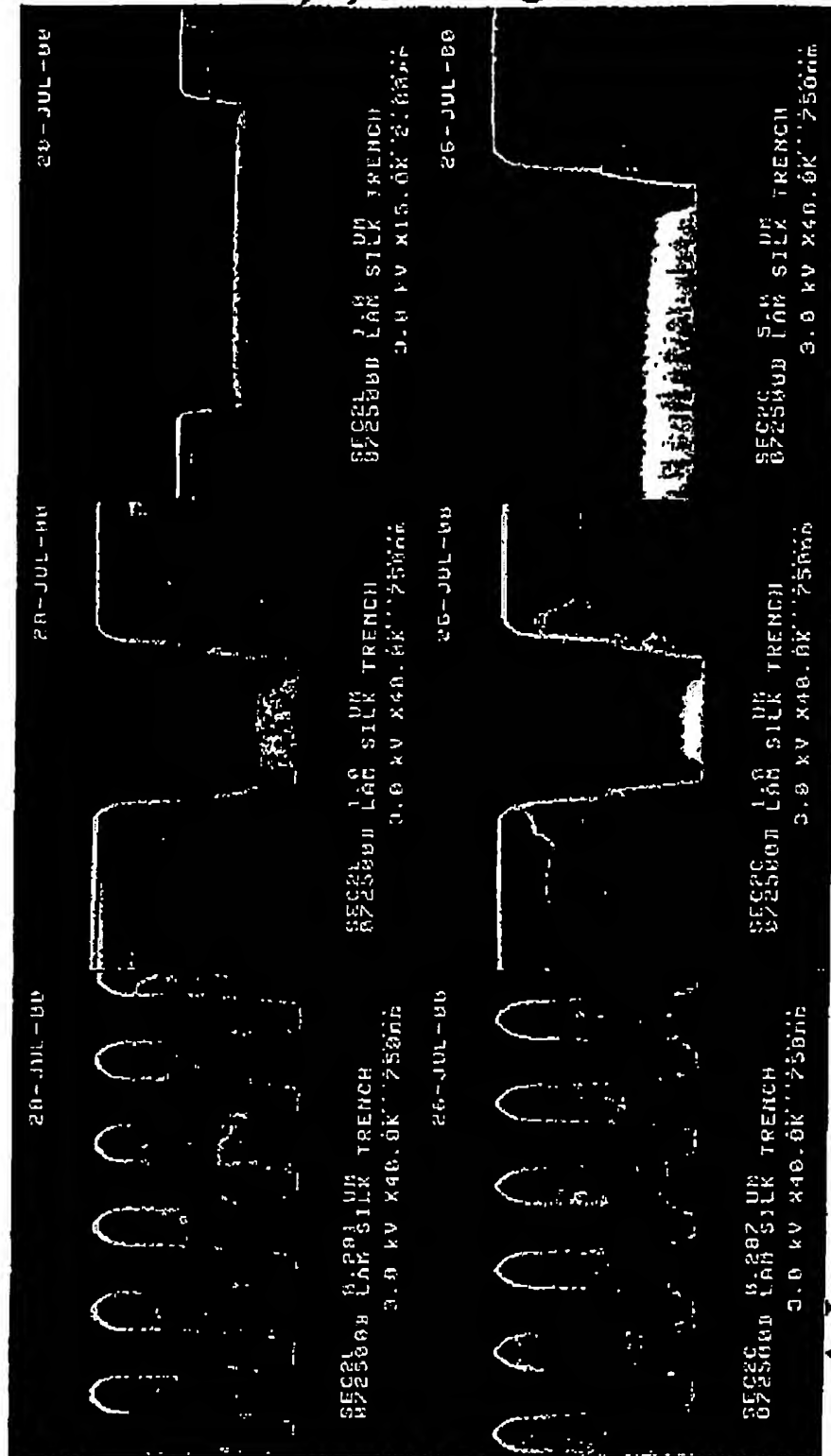


Confidential

07/31/00 Chok Ho (SILK Etch Development)

2002/1/8 70

Wafer # 072500B (ESC @ 0°C) (45.9% Overetch)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 160 mT/ 500/ 0/ 600 NH3/ 210" (PR Cleared @ 95")



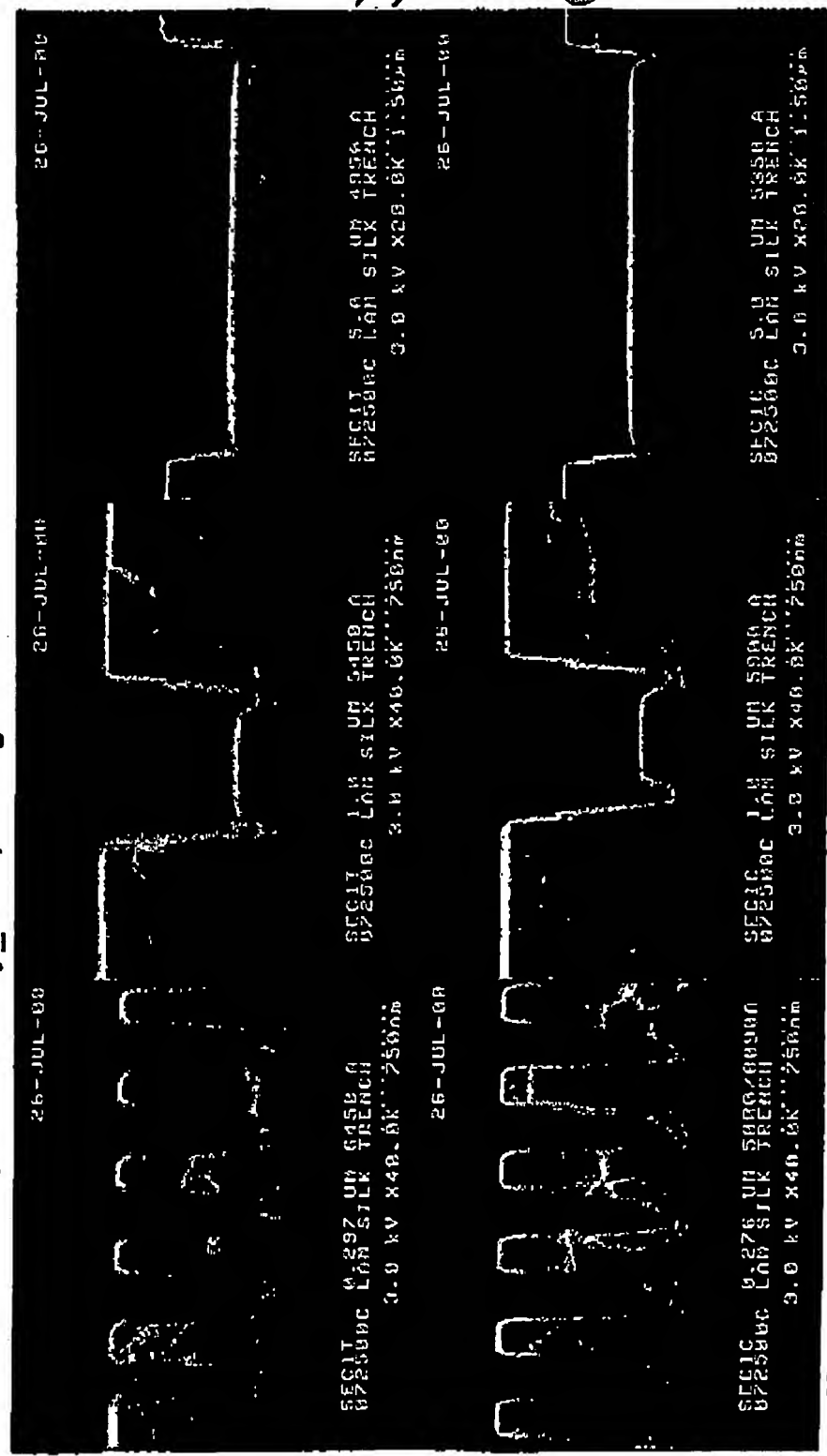
Confidential

07/31/00 Chok Ho (Silk Etch Development)

08/1/00

Wafer # 072500C (ESC @ 0°C) (Partial Etch)
70 mT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
160 mT/ 500/ 0/ 1000 NH3/ 95"

ER = 3853 A/min; ER Uniformity \leq 4.0%; RIE Lag = -18.3%



SECIC should be 6600A



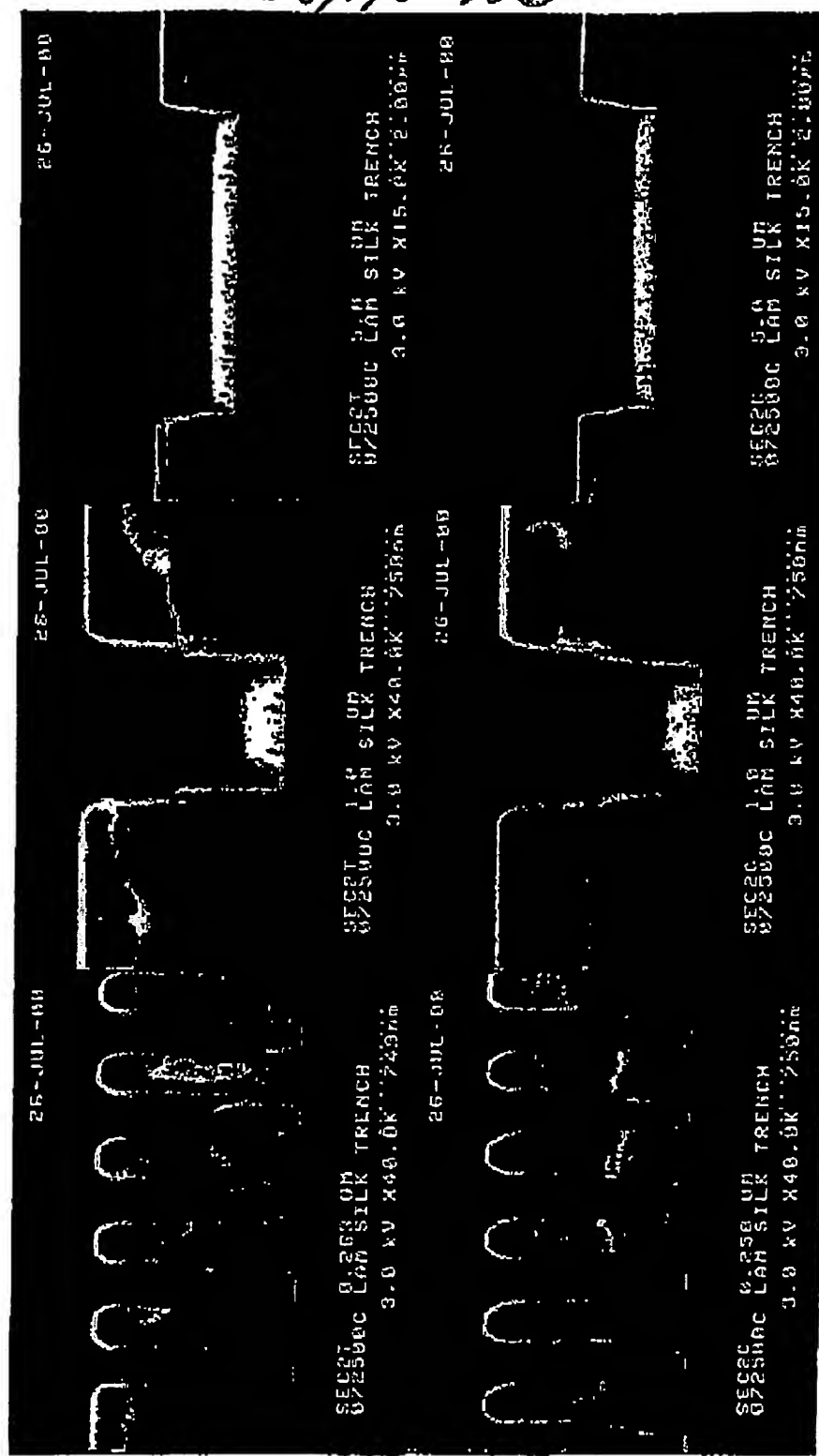
Confidential

07/31/00 Chok Ho (SILK Etch Development)

6/1/8 4:00

8/1/8 700

Wafer # 072500B (ESC @ 0°C) (16.3% Overetch)
70 MT/ 500/ 1K/ 160 A/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
55 mT/ 1400/ 1K/ 140 A/ 9 O2/ 15 C4F8/ 10"
160 mT/ 500/ 0/ 1000 NH3/ 172" (PR Cleared @ 84")



Confidential

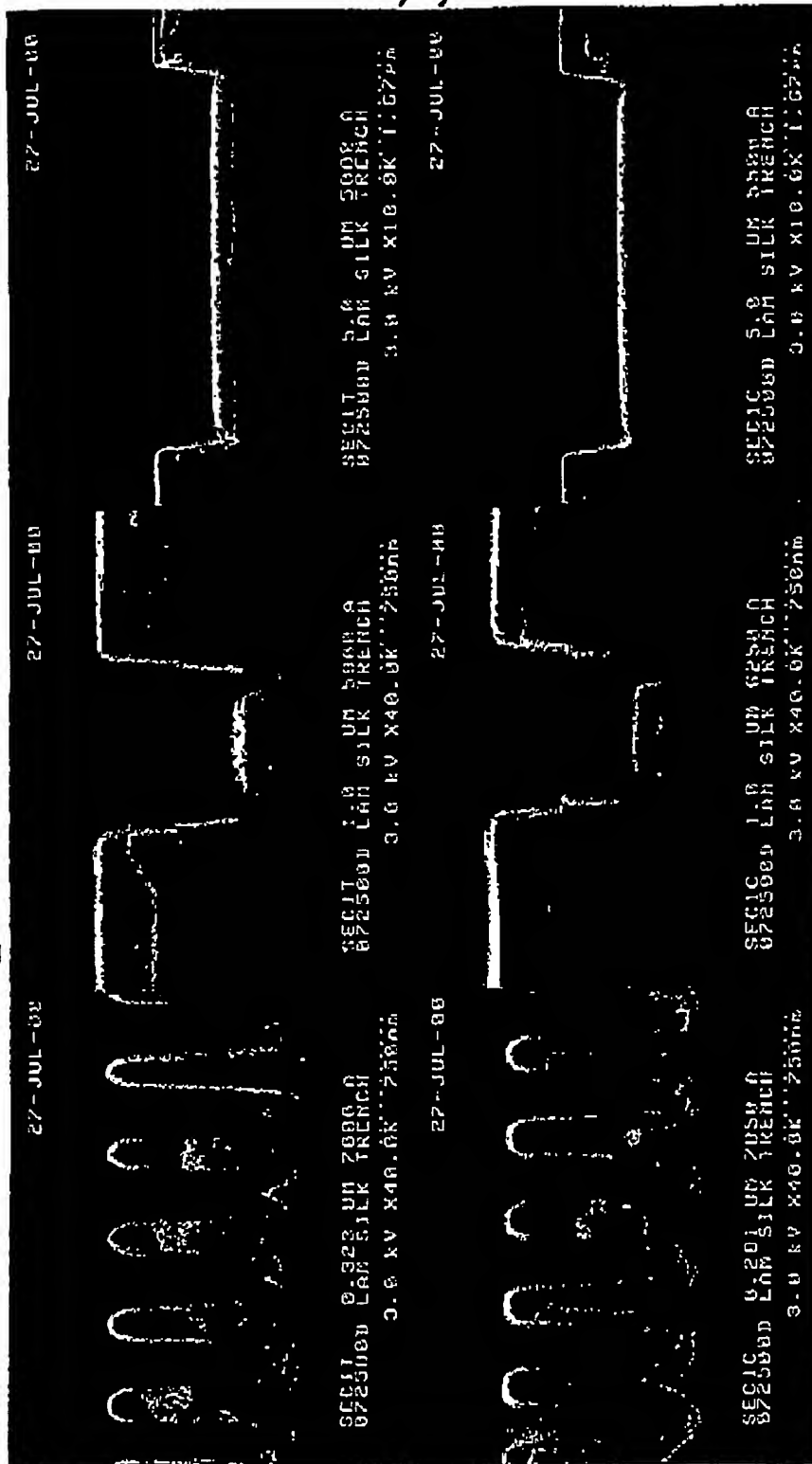
07/31/00 Chok Ho (SILK Etch Development)

6/1/9 470

27/1/2 20

Wafer # 072500D (ESC @ 0°C) (Partial Etch)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 100 mT/ 500/ 0/ 600 NH3/ 115"

ER = 3509 A/min; ER Uniformity \leq 5.7%; RIE Lag = - 25.6%



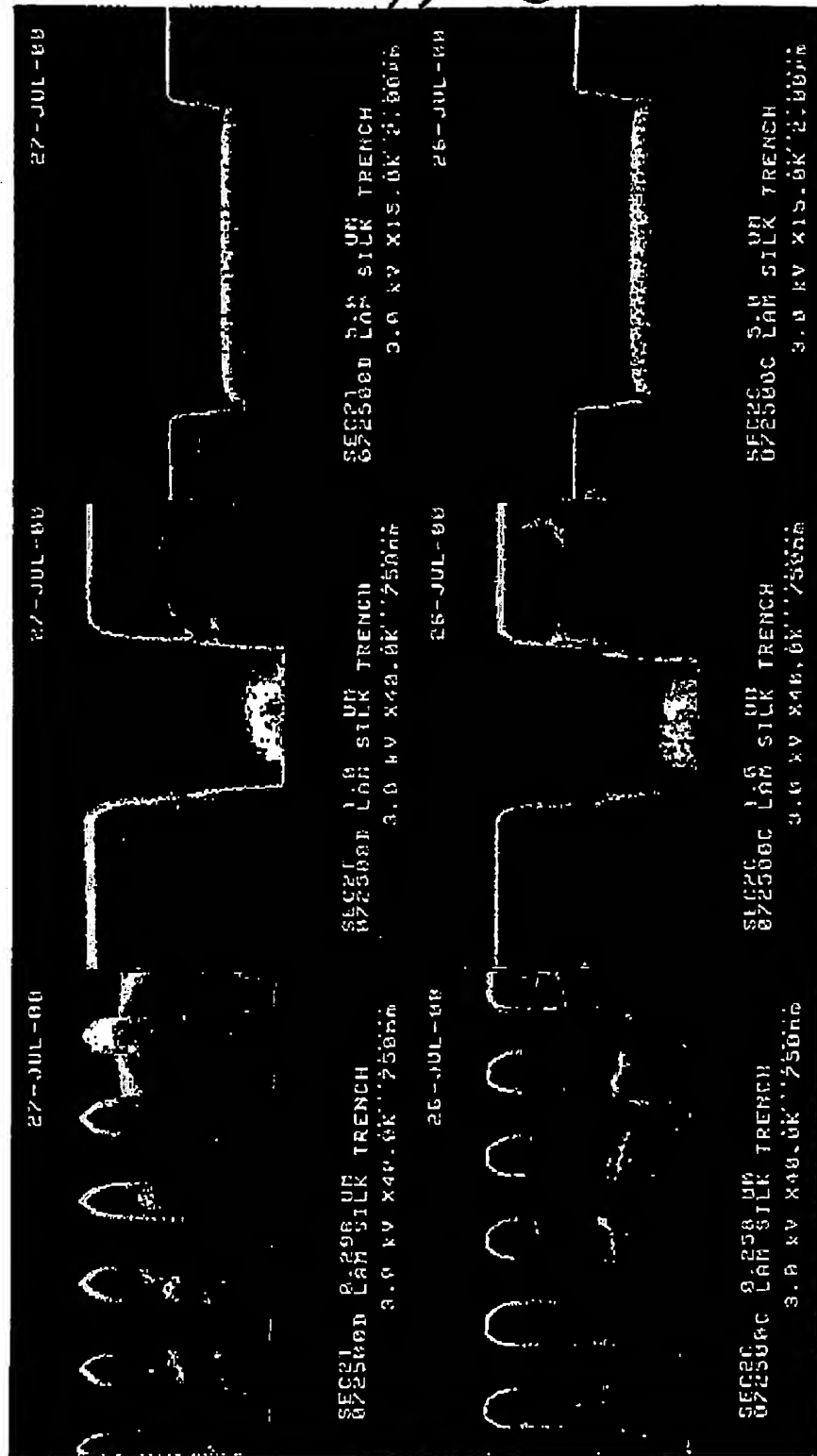
SEC1C should be 6800A



Confidential

07/31/00 Chok Ho (Silk Etch Development)

Wafer # 072500D (ESC @ 0°C) (29.3% Overetch)
 70 MT/ 500/ 1K/ 160 A/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 A/ 9 O2/ 15 C4F8/ 10"
 100 mT/ 500/ 0/ 600 NH3/ 210" (PR Cleared @ 78")

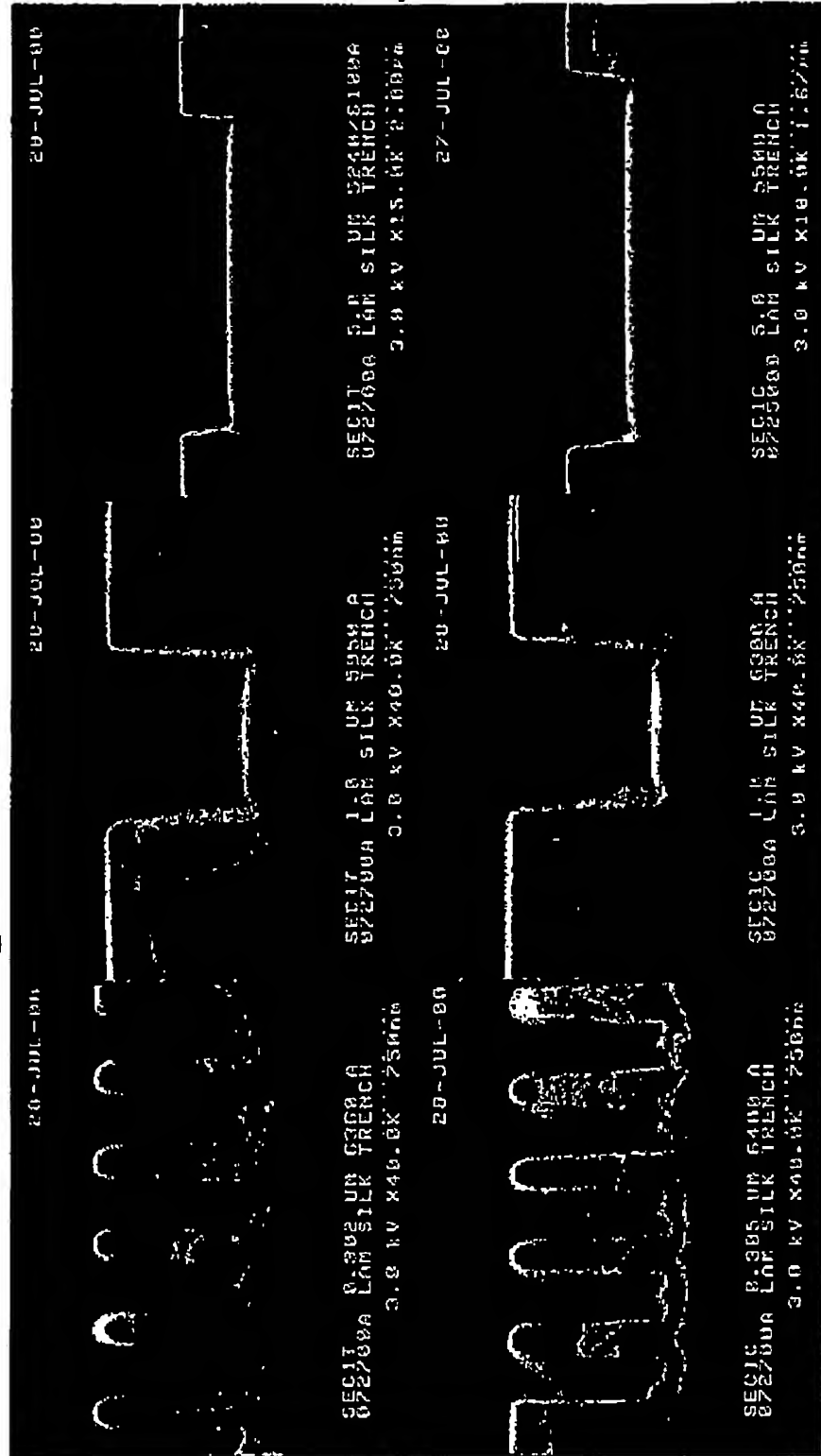


Confidential

07/31/00 Chok Ho (Silk Etch Development)

Wafer # 072700A (ESC @ 20°C) (Partial Etch)
 70 MT/ 500/ 1K/ 160 Ar/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 Ar/ 9 O2/ 15 C4F8/ 10"
 160 mT/ 500/ O/ 600 NH3/ 100"

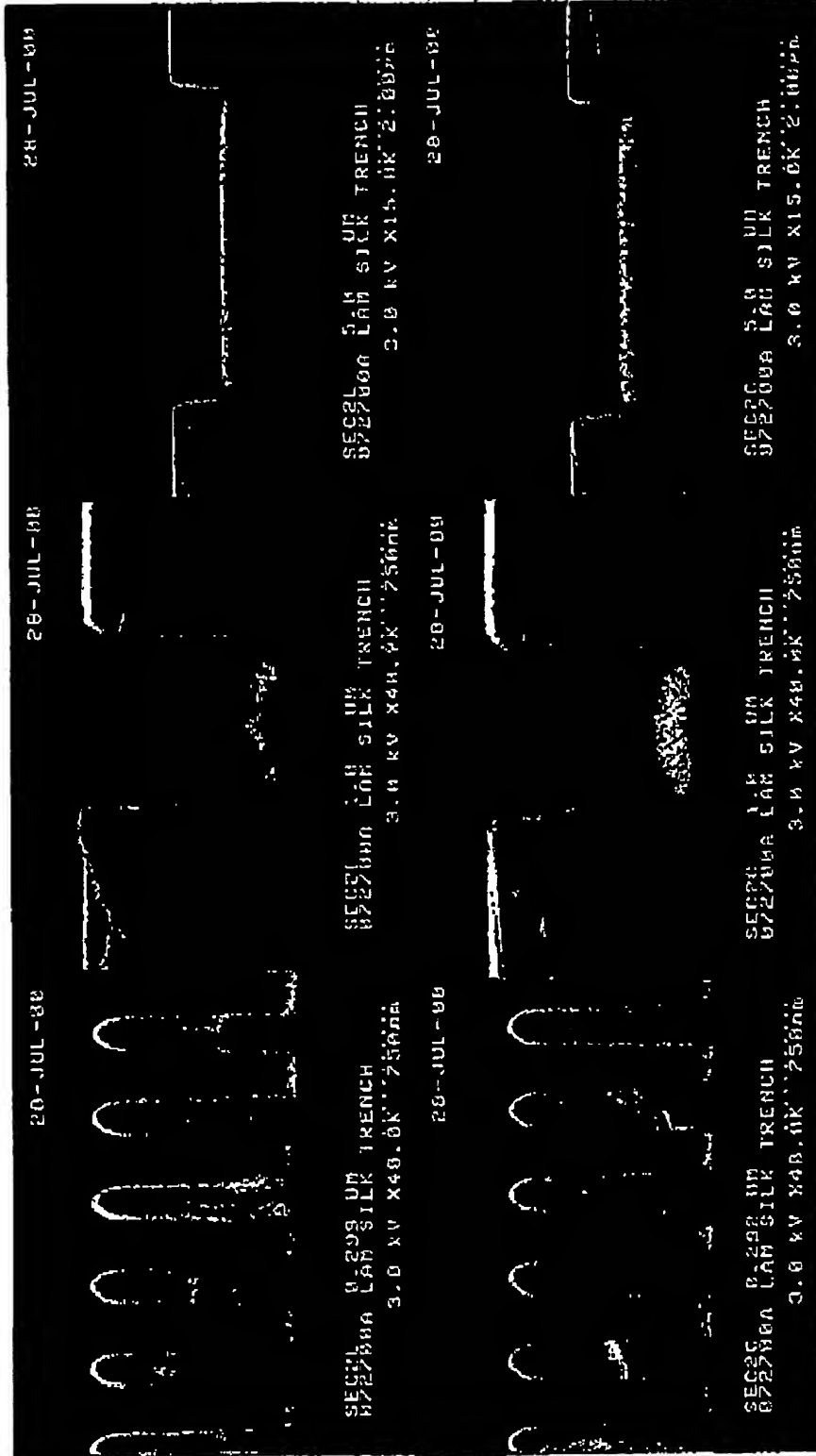
ER = 3752 Å/min; ER Uniformity \leq 2.9%; RIE Lag = - 6.9%



Confidential

07/31/00 Chok Ho (SILK Etch Development)

Wafer # 072700A (ESC @ 20°C) (1% Underetch)
 70 MT/ 500/ 1K/ 180 A/ 15 O2/ 5 C4F8/ 40 CF4/ 28"
 55 mT/ 1400/ 1K/ 140 A/ 9 O2/ 15 C4F8/ 10"
 160 mT/ 500/ 0/ 600 NH3/ 150" (PR Cleared @ 82")



Confidential

07/31/00 Chok Ho (SILK Etch Development)

SUMMARY

▲ Increasing NH3 Flow:

- Increases ER, decreases ER Non-uniformity, decreases RIE Lag

▲ Decreasing Pressure:

- Decreases ER, decreases ER Non-uniformity, decreases RIE Lag

▲ Increasing ESC Temperature*:

- Decreases ER, decreases ER Non-uniformity, decreases RIE Lag



Confidential

07/31/00 Chok Ho (SILK Etch Development)

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.